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METHOD FOR THE MANUFACTURE OF GAS-PERMEABLE FILM

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[There are no amendments to this patent.]

Claims

1. Method for the manufacture of gas-permeable film, characterized by melt lamination of a resin composition containing 100 parts by weight of a thermoplastic resin and 50-400 parts by weight of a filler on a nonwoven fabric of 10-400 μm thickness, followed by stretching the nonwoven fabric uni- or biaxially at a draw ratio of 1.1-3.0, wherein the nonwoven fabric contains a resin component with a melting point that is above 40°C, but more than 50°C lower than the melt lamination temperature of the resin composition.

2. The method of Claim 1, wherein the nonwoven fabric comprises two or more resin components with one or more resin components having a melting point above 40°C but more than 50°C lower than the melt lamination temperature of the resin composition, and a portion or entirety of the nonwoven fabric surface is such resin component.

3. The method of Claim 1, wherein the nonwoven fabric is made of a fiber having core and sheath layers, and at least the outermost layer of the sheath layer has a melting point higher than 40°C but more than 50°C lower than the melt lamination temperature of the resin composition.

4. The method of Claim 1, wherein the thermoplastic resin comprises one or more resins and contains more than 40 wt% of a resin having a density above 0.920 g/cm³.

Detailed explanation of the invention

Industrial application field

The present invention concerns a method for the manufacture of gas-permeable films, more specifically a method for the manufacture of gas-permeable films that are permeable to air and water vapor but not to water, for providing gas-permeable films with high strength and high water pressure resistance.

Prior art

Conventionally, gas-permeable films permeable to air, water vapor, etc., but not water have been used as back sheets for paper diapers and for packaging moisture absorbents, oxygen removers, etc. A method for making them involves, as shown in Japanese Kokai Patent Application No. Sho 60[1985]-229731, film formation from compositions comprising resins and fillers and in some cases also hydrocarbon polymer waxes, followed by stretching with formation of internal voids in the films for enabling gas permeability. However, the films comprising resins and fillers have limits in their tensile strength and tear strength. High stretchability also causes problems of low water pressure resistance with formation of microvoids between the resins and fillers (regions of large microvoids and small microvoids) which may cause nonuniform gas permeability and strength properties.

In some methods for solving such problems, reinforcements such as nonwoven fabrics are incorporated into the gas-permeable films. For example, in Japanese Kokai Patent Application No. Sho 63[1988]-286330, a nonwoven fabric is partially attached to gas-permeable films, or in Japanese Kokai Patent Application No. Sho 63[1988]-116849 and Japanese Kokai Utility Model No. Sho 63[1988]-136926, the entire area of a gas-permeable film is attached to a nonwoven fabric via an adhesive layer.

However, in the case of partial attachment of a gas-permeable film and a nonwoven fabric, there are differences in gas permeability between the attached and unattached areas, with stress concentration in the unattached area resulting in reduced water pressure resistance. This is not favored. In the case of the attachment of a nonwoven fabric on the entire gas-permeable film via an adhesive layer, unless the adhesive layer is made thin and uniform, gas permeability variation may occur with uneven adhesive strength.

Means to solve the problems

As a result of continuous effort to obtain gas-permeable film with high uniformity, high gas permeability, and high strength, we have discovered that such films can be obtained by laminating a resin composition containing a resin and a filler on a certain nonwoven fabric and then stretching the nonwoven fabric. Thus, the present invention is attained.

Namely, the present invention concerns a method for the manufacture of gas-permeable film, characterized by melt lamination of a resin composition containing 100 parts by weight of a thermoplastic resin and 50-400 parts by weight of a filler on a nonwoven fabric of 10-400 μm thickness, followed by stretching the nonwoven fabric uni- or biaxially at a draw ratio of 1.1-3.0,

wherein the nonwoven fabric contains a resin component with a melting point that is above 40°C, but more than 50°C lower than the melt lamination temperature of the resin composition.

The thermoplastic resins used in the gas-permeable film are, e.g., α -olefin homopolymers such as low-density polyethylene, high-density polyethylene, polypropylene, polybutene, etc.; ethylene copolymers with one or more α -olefins with 3-18 carbon atoms, copolymers of propylene and ethylene and/or butene-1, ethylene copolymers with vinyl acetate and/or organic carboxylic acid derivatives having ethylenically unsaturated bonds such as acrylate esters, methacrylate esters, etc.

Especially, ethylene copolymers with one or more α -olefins with 3-8 carbon atoms are preferred in terms of strength when compounded with fillers. Also, blends of low-density polyethylene with ethylene copolymers with one or more α -olefins with 3-8 carbon atoms are preferred in terms of film processability and stretchability. In the present invention, high gas permeability is realized at a low stretch ratio of 1.1-3.0; thus, the thermoplastic resin should contain a resin with density above 0.920 g/cm³.

In the present invention, with the filler content below 50 parts by weight to 100 parts by weight of the thermoplastic resin, development of gas permeability after stretching is difficult, while above 400 parts by weight, processability is very poor. Especially in terms of processing stability, the preferred filler content is 70-200 parts by weight.

Examples of fillers include carbonate salts such as calcium carbonate, magnesium carbonate, barium carbonate, etc.; sulfate salts such as barium sulfate, magnesium sulfate, calcium sulfate, etc.; phosphate salts such as magnesium phosphate, calcium phosphate, etc.; hydroxides such as magnesium hydroxide, aluminum hydroxide, etc.; oxides such as alumina, magnesium oxide, calcium oxide, zinc oxide, titanium oxide, etc.; chlorides such as zinc chloride, iron chloride, sodium chloride, etc.; other inorganic fillers such as aluminum powder, zeolites, shirasu*, white earth, kieselguhr, talc, carbon black, volcanic ash, etc.; cellulosic powders such as wood powder, pulp powder, etc.; synthetic resin powders such as nylon powder, polycarbonate powder, polypropylene powder, poly-4-methylpentene-1 powder, etc.; organic fillers such as starch, etc. These may be used singly or as mixtures thereof. In terms of film gas permeability, flexibility, appearance, etc., calcium carbonate is especially preferred. The filler should have an average particle diameter 0.1-20 μ m for film uniformity and especially 0.8-5.0 μ m for processability.

In the present invention concerning laminating a gas-permeable nonwoven fabric with a resin composition that develops gas permeability upon stretching, followed by stretching of the nonwoven fabric, the nonwoven fabric should have a thickness of 10-400 μ m. Below 10 μ m, the

* [Translator's note: a type of white clay produced in Kyushu, Japan]

desired strength can not be expected after stretching, while above 400 μm , stretchability is poor, and is thus not favored.

In the present invention involving stretching of the nonwoven fabric after melt lamination, if the adhesive strength between the resin composition and nonwoven fabric is not high, delamination may occur during stretching. Thus, the nonwoven fabric used contains at least one low-melting resin component having a melting point above 40°C, but more than 50°C lower than the melt lamination temperature of the resin composition. Such nonwoven fabrics include, e.g., a single resin component-based nonwoven fabric impregnated with a solution of such a low-melting resin component, those formed from two or more resin components in fiber form, and nonwoven fabrics prepared from fibers from two or more resin components. The nonwoven fabrics prepared from fibers from two or more resin components are, e.g., concentric multilayer types having a core layer and a sheath layer, non-concentric multilayer types in which the sheath layer is partially or wholly a low-melting resin, or at least a portion of the fiber is such a low-melting resin that appears continuously or discontinuously on the fiber surface. Especially, in terms of nonwoven fabric strength, preferred nonwoven fabrics comprise fibers having core and sheath layers and at least the outermost layer of the sheath layer is the low-melting resin component. When the difference between the melt lamination temperature and the melting point of the resin component constituting partially or wholly the nonwoven fabric is less than 50°C, desired adhesive strength is not realized in the melt lamination, and is thus not favored. When the resin component melting point is below 40°C, especially in film processing in warm locations, the film tackiness increases markedly, making separation from rolls difficult which leads to various problems, and is thus not favored.

Examples of resin components partially or wholly constituting the nonwoven fabric include polyester, nylon, α -olefin homopolymers such as polyethylene, polypropylene, polybutene, etc.; ethylene copolymers with one or more of α -olefins with 3-18 carbon atoms, propylene copolymers with ethylene and/or butene-1, ethylene copolymers with vinyl acetate and/or organic carboxylic acid derivatives having ethylenically unsaturated bonds such as acrylate esters, methacrylate esters, etc.

Especially in terms of processability, strength, and adhesion, the core layer should be from polyester and the sheath layer should be from polyethylene, e.g., Elvace of Unitika Co., NBF of Daiwa Boseki Co., and Sofit of Kuraray Co.

For the gas-permeable film of the present invention, the resin composition can be obtained in the usual manner by mixing thermoplastic resin with fillers and, if needed, dispersants and stabilizers using a roll or Banbury mixer or a single- or twin-screw extruder. The compositions thus obtained are laminated to a thickness of 5-150 μm on a nonwoven fabric. Then the fabric is stretched uni- or biaxially. In uniaxial stretching, normal roll stretching is

preferred. Biaxial stretching may be simultaneous or can be done by longitudinal and then transverse stretching. The appropriate stretch ratio may vary depending on the resin composition and type of nonwoven fabric, but it should be in the range of 1.1-3.0. Below 1.1, gas permeability can not be expected, while above 3.0, material breakage may occur, with reduced tear strength in the longitudinal direction. A further preferred stretch ratio is 1.2-2.0. The stretching temperature may vary depending on the resin composition, but it is usually 30-140°C. Below 30°C, stability during stretching is poor, while above 140°C, microvoid formation is poor, and is thus not favored. Especially, stretching at 30-140°C, followed by heat setting at 80-170°C is preferred in terms of preventing film wrinkling.

Function

In the present invention, melt lamination of resin compositions from 100 parts by weight of thermoplastic resin and 50-400 parts by weight of filler on a nonwoven fabric, followed by stretching allows expansion of the adhesion area of the nonwoven fabric and porous film and uniform microvoid formation to obtain uniform gas permeability and strength.

In the present invention, by melt lamination of resin compositions on certain nonwoven fabrics, the stretching initiation point for the subsequent stretching can be spread widely, by which films of uniform gas permeability and uniform strength can be obtained.

Since treatments such as adhesion, fusion, etc., after stretching are not carried out, loss of gas permeability and strength do not occur.

Effect of the invention

The gas-permeable films obtained by the method of the present invention are excellent in strength and gas permeability, which are uniform throughout the film. They can be used as packaging materials requiring uniform gas permeability for moisture absorbents, oxygen removers, etc., and in applications requiring high strength and moisture permeability, such as wall paper, cloth covers, etc.

Application Examples

Next, examples are described in detail. However, the present invention is not limited to such examples. Moisture permeability, water pressure resistance, strength, stretching variation, adhesion between nonwoven fabric and resin composition shown for examples are evaluated by the following standards.

Gas permeability:

According to JIS Z0208, for permeability for moisture at 40°C and 90%RH.

Water pressure resistance:

According to JIS L1092-A by measuring the water level at three places at the back of the test specimen.

Stretching variation:

By visual inspection with the following evaluation from X to O:

O: no variation, uniform stretching.

Δ: nonuniform stretching at some locations with the distance between stretched parts less than 5 mm.

X: apparent nonuniform stretching with a number of unstretched parts exceeding 5 mm.

Adhesion:

By visual inspection and a touch test for adhesion between the nonwoven fabric and the thermoplastic resin composition film after stretching by the following standards of X to O.

O: no delamination, uniform adhesion.

Δ: partial delamination between the nonwoven fabric and film; delamination occurred from touching by hand.

X: total delamination between the nonwoven fabric and film.

Application Example 1

A composition from 100 parts by weight of thermoplastic resin comprising 75 wt% linear low-density polyethylene (Sumikathene αCS3003, density 0.932 g/cm³, product of Sumitomo Kagaku Kogyo Co.) and 25 wt% high-pressure low-density polyethylene (Sumikathene F208-0, density 0.922 g/cm³, product of Sumitomo Kagaku Kogyo Co.) and 150 parts by weight of calcium carbonate (Whiton SSB (red), product of Shiraishi Calcium Co.) was kneaded in a Banbury kneader, laminated at a basis weight of 30 g/m² at resin temperature 270°C to a nonwoven fabric (Elvace S0303WDO, product of Unitika Co.) of thickness 100 μm and basis weight 30 g/m² from a concentric fiber of polyester (m.p. 257°C) core and polyethylene (m.p. 124°C) sheath. The laminated film was then stretched uniaxially using a roll stretcher at 50°C and at a stretch ratio 1.3 to obtain a gas-permeable film. As shown in Table I, the gas-permeable film obtained had high gas permeability, good water pressure resistance, strength, stretching uniformity (no variation) and adhesion.

Application Example 2

Application Example 1 was repeated using a nonwoven fabric (prepared by a normal dry process) from non-concentric fiber (ES fiber, with a core layer partially exposed on the fiber surface, product of Chisso Co.) with a polypropylene (m.p. 165°C) core and a polyethylene (m.p. 130°C) sheath. The fabric had a thickness of 150 μm and a basis weight of 20 g/m^2 . The gas-permeable film obtained had good properties as in Application Example 1.

Application Example 3

A gas-permeable film was prepared by repeating Application Example 1 using a polypropylene (m.p. 165°C) nonwoven fabric (Polypro Spun Bond P1015, product of Asahi Kasei Co.) coated with 5 wt% ethylene-butene-1 copolymer by impregnation of a solution of ethylene-butene-1 copolymer (m.p. 115°C, density 0.900 g/cm^3) in xylene. The coated nonwoven fabric had a thickness of 200 μm and a basis weight 20 g/m^2 . The gas-permeable film obtained had good properties as shown in Table I.

Application Example 4

A gas-permeable film was obtained by repeating Application Example 1 using a nonwoven fabric (thickness 200 μm , basis weight 25 g/m^2 , fiber size 2 denier) obtained by the method of Japanese Kokai Patent Application No. Hei 1[1989]-15614 (with roll pressing at 130°C and linear pressure 40 kg/cm after interlacing and drying) from a composition obtained by melt kneading 35 wt% polyethylene (Sumikathene L FA202-0, m.p. 124°C, product of Sumitomo Kagaku Kogyo Co.), 60 wt% nylon (nylon 6, A1030BRT, m.p. 215°C, product of Unitika Co.), and 5 wt% maleic anhydride ternary copolymer (Bondine FX8000, available from Sumika CDF Kagaku Co.). The gas-permeable film obtained had good properties as shown in Table I.

Application Example 5

A gas-permeable film was obtained by repeating Application Example 1 using linear low-density polyethylene (Sumikathene αCS3003 , density 0.932 g/cm^3 , product of Sumitomo Kagaku Kogyo Co.) as the thermoplastic resin and titanium dioxide (R101, product of Dupont Co.) as the filler under the processing conditions shown in Table I. The gas-permeable film thus obtained had good properties as shown in Table I.

Comparative Example 1

A gas-permeable film was obtained by repeating Application Example 1 under stretching conditions shown in Table I without using the nonwoven fabric. The gas-permeable film thus obtained showed markedly low tensile strength and water pressure resistance with stretching variation.

Comparative Example 2

A gas-permeable film was obtained by repeating Application Example 1 using 40 parts by weight of calcium carbonate (Whiton SSB (red), product of Shiraishi Calcium Co.). The gas-permeable film thus obtained had markedly low gas permeability as shown in Table I.

Comparative Example 3

The process of Application Example 1 was repeated using 100 parts by weight of high-pressure low-density polyethylene (Sumikathene F208-0, density 0.922 g/cm^3 , product of Sumitomo Kagaku Kogyo Co.) as the thermoplastic resin and 500 parts by weight of calcium carbonate (Whiton SSB (red), product of Shiraishi Calcium Co.) as the filler. During processing, breakage occurred at the resin composition side, and gas-permeable film could not be obtained.

Comparative Example 4

A gas-permeable film was obtained by repeating Application Example 1 using a polyester (m.p. 257°C) nonwoven fabric. The gas-permeable film thus obtained had poor adhesion between the nonwoven fabric and film as shown in Table I.

Comparative Example 5

A gas-permeable film was obtained by repeating Application Example 1 with lamination at 160°C . The gas-permeable film thus obtained had poor adhesion between the nonwoven fabric and film as shown in Table I.

Comparative Example 6

A gas-permeable film was obtained in the same way as described in Application Example 1 except for using 75 wt% of linear low-density polyethylene (Excelen VL VL200, density 0.900 g/cm³, product of Sumitomo Kagaku Kogyo Co.) as the thermoplastic resin. As shown in Table I, the gas-permeable film thus obtained had very low gas permeability and severe stretching variation.

Table I

⑦	① 樹脂組成物				② 不純物		③ 加工条件				④ 物性等				
	⑤ 延伸性樹脂 (密度) (g/cm ³)	⑥ 充填剤 (重量%)	⑧ 種類 (g)	⑩ 含量 (重量%)	⑨ タイプ	⑪ 組成成分 (%)	⑬ 温度 (°C)	⑭ 時間 (min)	⑮ 延伸率 (%)	⑯ 延伸速度 (g/cm ² ・day)	⑰ 延伸率 (%)	⑱ 延伸速度 (g/cm ² ・day)	⑲ 延伸率 (%)	⑳ 延伸速度 (g/cm ² ・day)	㉑ 延伸率 (%)
実施例 1	0.932 0.922	75 25	CaCO ₃ (SSR 併用)	150	石粉同心	124, 257	100	270	30	50	1.3	10000	1700	2000	○
実施例 2	0.932 0.922	75 25	CaCO ₃ (SSR 併用)	150	石粉同心	130, 185	150	180	30	50	1.3	10500	1100	1800	○
実施例 3	0.932 0.922	75 25	CaCO ₃ (SSR 併用)	150	石粉同心	115, 185	200	180	30	50	1.3	9000	900	1000	○
実施例 4	0.932 0.922	75 25	CaCO ₃ (SSR 併用)	150	石粉同心	124, 215	200	270	60	50	1.3	9000	2000	2500	○
実施例 5	0.932	100	TiO ₂ (R101)	150	石粉同心	124, 257	100	270	60	60	1.2	8000	1800	2500	○
比較例 1	0.932 0.922	75 25	CaCO ₃ (SSR 併用)	150	---	---	---	270	50	50	1.3	11000	500	100	×
比較例 2	0.932 0.922	75 25	CaCO ₃ (SSR 併用)	40	石粉同心	124, 257	100	270	30	50	1.3	160	---	---	---
比較例 3	0.922	100	CaCO ₃ (SSR 併用)	500	石粉同心	124, 257	100	270	100	樹脂組成物が破断し延伸不可					
比較例 4	0.932 0.922	75 25	CaCO ₃ (SSR 併用)	150	石粉同心	257	100	270	30	50	1.3	---	---	---	---
比較例 5	0.932 0.922	75 25	CaCO ₃ (SSR 併用)	150	石粉同心	124, 257	100	180	30	50	1.3	---	---	---	---
比較例 6	0.900 0.922	75 25	CaCO ₃ (SSR 併用)	150	石粉同心	124, 257	100	270	30	50	1.3	1000	1700	2500	△

③③ 注 1) 延伸性樹脂中における密度の異なる各々の樹脂の割合。
注 2) 延伸性樹脂 100 重量部に対する充填剤量。

Key:	1	resin composition
	2	nonwoven fabric
	3	processing conditions
	4	properties
	5	thermoplastic resin
	6	filler
	7	density
	8	content (wt%), note 1)
	9, 11	type
	10	content (wt%), note 2)
	12	resin component melting point
	13	thickness
	14	lamination
	15	stretching
	16, 18	temperature
	17	resin composition basis weight
	19	stretch ratio
	20	gas permeability
	21	tensile breaking point load
	22	water pressure resistance
	23	stretching variation
	24	adhesion
	25	application example
	26	comparative example
	27	red
	28	concentric sheath-core
	29	non-concentric sheath-core (side-by-side)
	30	impregnation coating
	31	melt blend of different polymers
	32	stretching not possible due to breakage at the resin composition side
	33	Note 1) ratio of each resin with different density in the thermoplastic resin. Note 2) filler content based on 100 parts by weight of thermoplastic resin.